GOVERNMENT INTEREST

[0001] The invention described herein may be made, used, and licensed by, or for, the United States Government for governmental purposes without paying me any royalty.

BACKGROUND AND SUMMARY

[0002] This invention pertains to a continuous visual indicator to monitor the status of an electrical protection device (EPD) that has been located within an electrical circuit to prevent current overload. Also provided herein is a ready means for visual detection of whether an EPD is performing its intended, protective function. In those instances where the EPD has opened (failed), my visual indicator (light emitting diode) will not be illuminated. If the EPD is closed (sound or intact), my visual indicator will be illuminated and visible. The general public will find these arrangements are intuitive, easily understood, and accepted. The term EPD as used herein includes circuit breakers, automotive fuses, screw-in fuses, cartridge protective device, and the like. My visual indicators are also incorporated easily into either direct or alternating current systems.

[0003] EPDs provide protection in modern electrical circuits to prevent a variety of unsafe electrical conditions, such as current shorts, faults, overloads, and even fires. Normally, circuit designers of electrical systems will position an EPD at a point within the circuit that is between a power source and an electrical load. This arrangement will protect both the circuit and all of its specialized components. As used herein, an electrical load may be utilized to drive a device selected from the group of operating devices consisting of: an electrical, mechanical, or electro-mechanical device.

[0004] Present day electrical systems of industrial sites; homes; businesses; and air, ground, or water transports are normally composed of a multiplicity of complex, EPD-protected circuits. In operation, if a short or current spike occurs that will exceed an EPD's rating; the EPD will then fail and thereby interrupt current flow until it is either reset or replaced. Manual inspection of the open circuit is then necessitated to find which EPD(s) have failed or blown.

During this time, the electrical service to the affected circuit is terminated, and the intended function of said circuit is impaired or halted. Such a situation needs to be efficiently dealt with to keep the electrical system on-line.

[0005] In the past, the absence of visual indicators has consumed considerable time and effort to manually test, by trial and error techniques, one or more of the EPDs present within an electrical system to determine which EPD is open. Moreover, since most EPDs are typically centralized in service panels that are isolated in remote locations under reduced lighting conditions; such an effort has traditionally been a tedious and/or treacherous task to perform.

[0006] The less than desirable situations presented above are further exacerbated when the affected electrical circuit is a critical part of a much larger integrated system, such as a military installation; a weapons system or combat transport vehicle; a public safety facility, such as a prison, police station, or fire hall; and/or a health care facility with life-support equipment therein. Since these power requirements are unique, and do not likely allow considerable time to solve these problems; severe injury or death may be an expectable result.

[0007] To solve this problem, several inventors have proposed to incorporate with EPDs a variety of visual indicators, such as incandescent lamps and Light Emitting Diodes (LEDs), to expedite the performance of this task. Yet, these prior efforts have met with limited success because they typically involve a modification of the design parameters of the original system. In turn, this causes adverse impacts on design load, and impairs the electrical performance and/or efficiency of various components within the modified system. Moreover, these efforts are too costly or too complicated to achieve widespread acceptance.

[0008] The above-mentioned inventors have routinely taken one of the following general approaches. As a first approach, US 5,739,737 uses an intrusive effort that permanently connects a visual indicator **18** in parallel across the leads **24** of each EPD in a service panel. This is accomplished by insertion of an entire liner, individual plug-in(s), or similar change to, or within, the existing service panel. This patent will not work successfully if there is a high resistance in the electrical circuit. This approach is depicted in my Figure 1a wherein circuit

10 is provided between leads **24** that contains resistor **11** and LED **18**. Said circuit will essentially bypass current flow around EPD **22** when it fails to perform its intended function of moderating current flow from the power source **14** across the EPD to the electrical load **16**. The leads **24** are remote from the terminals **20** of the EPD. Optionally, a simple switch may be incorporated into Figure 1 between the power source **14** and the power side of lead **24**.

[0009] Figure 1b presents a second approach, as disclosed in US 5,701,118, that employs a hand-held, U-shaped tester **12**. This tester includes a resistor **13** and a visual indicator **18** which are temporarily connected across the leads **24** of said EPD in a parallel manner. This is graphically shown within said figure wherein the tester probes are depicted as arrows contacting the leads **24** of the EPD **22** in close proximity to the respective terminals **20**. A failed EPD will thereby be detected as the current flow is rerouted across the probes causing illumination of the visual indicator. This approach is time consuming, is labor intensive, and will not provide a continuous monitoring of every EPD-protected circuit in the service panel. It is also very difficult for this patent to successfully function if there is high resistance within the circuit of 5,000 ohms or more.

[0010] In a third approach, US 4,281,322 utilizes a testing device **26** for the detection of blown automotive fuses in a motor vehicle. A plurality of electrical circuits are protected therein by a multiplicity of EPDs ($\mathbf{F_1}$- $\mathbf{F_7}$) which are positioned between a common power source **1** and electrical loads ($\mathbf{L_1}$- $\mathbf{L_7}$). The cathode end of each LED ($\mathbf{D_1}$- $\mathbf{D_7}$) is linked to its respective EPD, and the anode end is directly connected to ground through a manual switch **5**. When manually closed, this switch stops the current flow to a particular electrical load and redirects it to ground through the LED. In routine operation, the closing of this switch causes the LED associated with a particular EPD to illuminate if the EPD is intact. If said fuse is blown, the LED will not illuminate. This approach is depicted herein by Figure 2.

[0011] None of the prior inventors disclose the many advantages and benefits of my claimed invention; nor do they teach or suggest my approach

or inventive elements. Moreover, the efforts by others have undesirably modified the initial design parameters for factory components and loads of each system.

[0012] It is therefore an object of the claimed invention to provide a permanent, visual status indicator within an electrical circuit which provides the appropriate circuitry for causing the indicator to continuously light whenever the EPD is intact and performing its intended function. It is another object to furnish an indicator with appropriate circuitry to cause the indicator to not be illuminated when the EPD has blown or failed. Such an illumination arrangement is useful for the quick and easy verification of electrical system integrity by minimal effort. It is a separate object of this invention to introduce such an indicator that may be used as an original equipment item or retrofitted to an existing system.

[0013] These and other objects, features, and advantages of this invention will be apparent to those skilled in the relevant arts upon a full reading of this specification and the appended claims which explain and define the aspects and principals of this invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] Figure 1a is a diagram of a circuit previously used in the prior art as discussed, supra, in Paragraph **[0008]**.

[0015] Figure 1b is a circuit diagram previously utilized in the art as disclosed above in Paragraph **[0009]**.

[0016] Figure 2 is a circuit diagram of the prior art as described in above paragraph **[0010]**.

[0017] Figure 3 is a simple diagram of my indicator circuit.

[0018] Figure 4 is a plan view of a circuit assembly previously used in the art including, in series, a power source, an electrical protection device, an electrical load, and a ground. Arrows therein depict current flow through said circuit assembly from power source to ground.

[0019] Figure 5 is a circuit assembly, similar to that of Figure 4, of my indicator circuit in operation. Arrows show current flow therein.

DETAILED DESCRIPTION

[0020] Figures 1 and 2 have been described before as prior art and further discussion is not made for the sake of brevity. Figure 3 is a diagram of an indicator circuit of this invention that employs common reference numerals for the sake of consistency. Like Figures 1-2, my circuit has an EPD **22** that has been positioned between a power source **14** and an electrical load **16**. If desired, a manual switch for circuit activation could be incorporated therein between said power source and the terminal **20** on the power side of the EPD. The anode of the EPD is electrically connected by conventional wiring to the power source, and its cathode is similarly connected to the electrical load via terminal **20** on the load side. At lead **24**, positioned between EPD cathode terminal **20** and the load **16**, my indicator circuit comprises a separate wiring of a series resistor $\mathbf{R_3}$ and a LED **18** that are electrically connected to ground, in that order. Arrows within Figure 3 depict the current path from the power source **14**, through the EPD **22**, to lead **24**, and ultimately to the ground through electrical load **16**. If EPD **22** fails, then the current path to lead **24** would open and the electrical load would cease to function. This failure would cause my LED **18** to not be illuminated and would simultaneously indicate that the EPD had either failed or needed to be reset.

[0021] Figure 4 is a diagrammatical depiction of a basic circuit assembly of the prior art that comprises a power source **14**, a panel receptor **26**, an EPD assembly **30**, an electrical load **16**, and a ground. For ease of assembly, the panel receptor **26** bears circuit connectors **28** that connect to EPD terminals **20** by any means of engineering choice. In turn, the EPD assembly **30** carries thereon EPD **22** and EPD terminals **20** which receive the circuit connectors **28**. Arrows within Figure 4 indicate the current flow therein. Again, a manual switch could be optionally included between the power source and the EPD.

[0022] Figure 5 is a simple diagrammatical depiction of the circuit assembly of Figure 4 including a structural adapter **32** incorporating an indicator circuit of this invention. Said adapter has dual connectors **34** that connect to the circuit connectors **28** of panel connector **26** and to the EPD terminals **20** of EPD assembly **30**. Current flow therein is again indicated by arrows. Extending to the

right from right-side dual connector **34** of structural adapter **32** is my monitoring circuit comprised of a series resistor R_3, a LED **18**, and a ground. Accordingly, the LED **18** of my circuit is always lit if the EPD **22** is intact and functioning in its normal manner. If the EPD fails, then LED **18** will not be illuminated indicating the lack of current flow due to the loss of electrical load. Thereby, I do provide herein a continuous visual indicator for the quick and convenient determination of the status of an EPD-protected electrical circuit.

[0023] I wish it understood that I do not desire to be limited to the exact details of construction or method shown herein since obvious modifications will occur to those skilled in the relevant arts without departing from the spirit and scope of the following claims.